

Influence of Wind on Re-suspension of Bacteria on Intertidal Sediment in Oakland Bay

John Konovsky, Levi Keesecker and Joe Puhn, Squaxin Island Tribe



Introduction

- In upper Oakland Bay (DOH Intertidal Station 614), the critical period for fecal coliform (FC) bacteria is late summer.
- In 2005 and 2006, summer bacteria counts exceeded water quality standards for shellfish harvest and other beneficial uses.
- DOH 614 was surrounded on all sides by other marine and freshwater stations with lower counts of bacteria.
- Two creeks (Cranberry & Deer) enter the estuary just north and south of DOH 614, but circulation studies suggested very little stream water interaction with marine water at DOH 614.
- A pilot investigation of potential secondary FC sources was initiated to try and develop a conceptual model for the summer critical period.
- The investigation focused on:
 - FC survival and growth at the intertidal sediment-marine snow interface.
 - Re-suspension of bacteria by wind and wave action.

Methods—Sediment

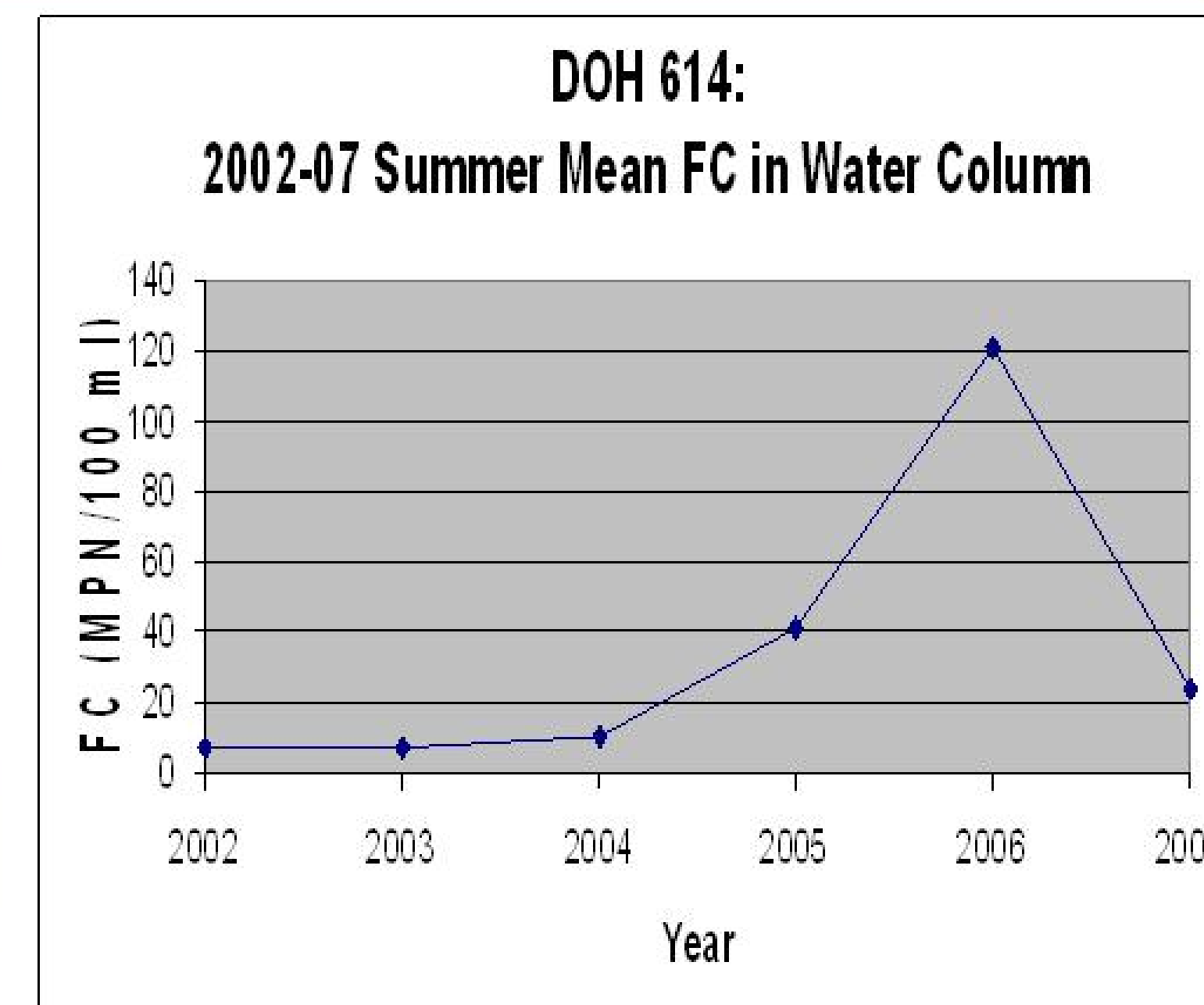
- For 27 weeks from May to November 2007, Squaxin collected 54 sediment samples at DOH 614 during low tides.
- On the same day at high tide, 54 water column samples were collected.
- The sediment samples were analyzed by Thurston County Environmental Health for FC (MPN) and dry weight.
- The water samples were analyzed by DOE Manchester Lab for FC (MF).
- The sample results were aggregated into months and presented as arithmetic means.

Results

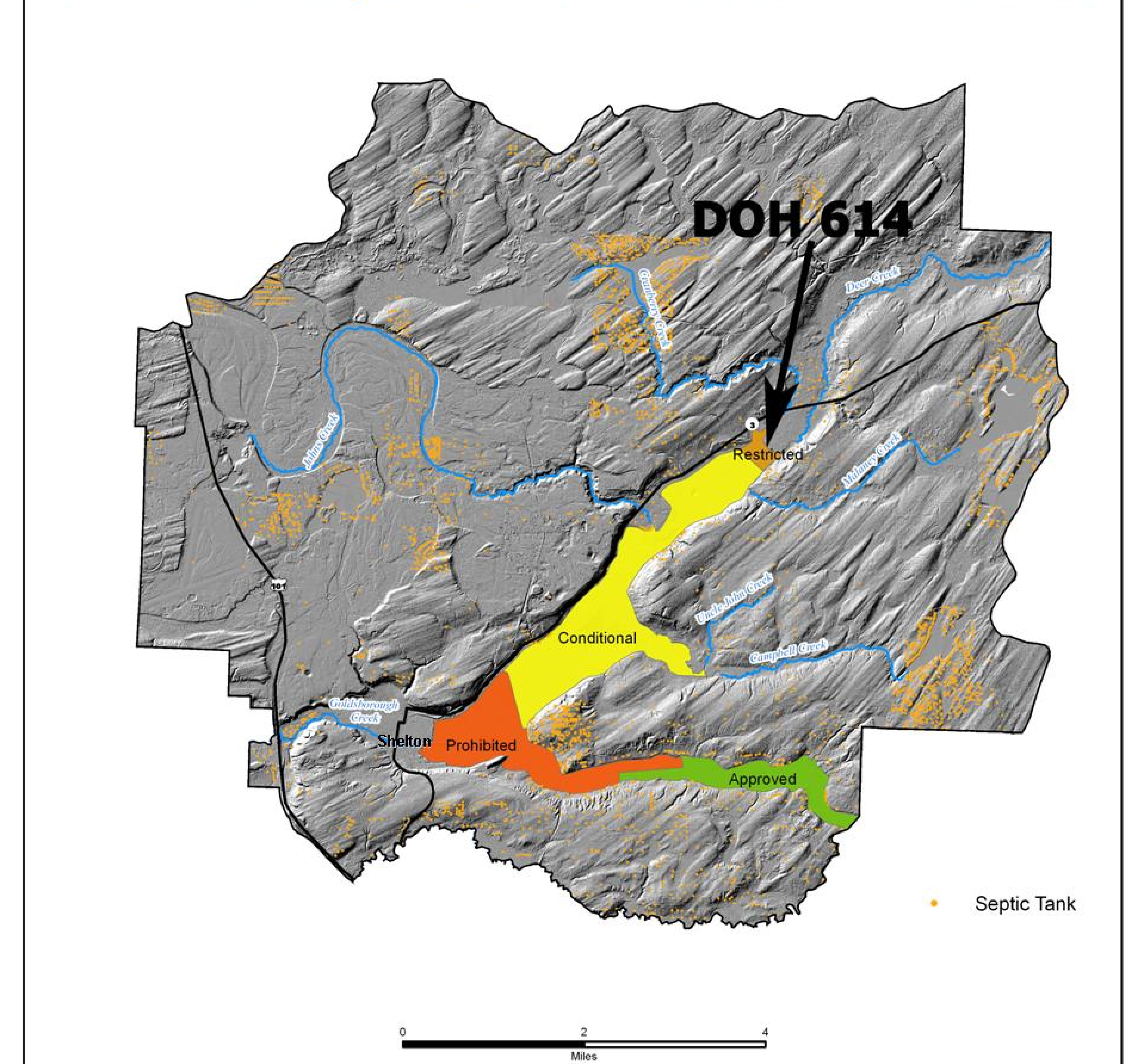
- Differences in monthly mean FC counts for sediment were not statistically significant.
- A weak relationship was noted between FC on sediment and in water column ($R^2 = 0.38$).

Conclusions

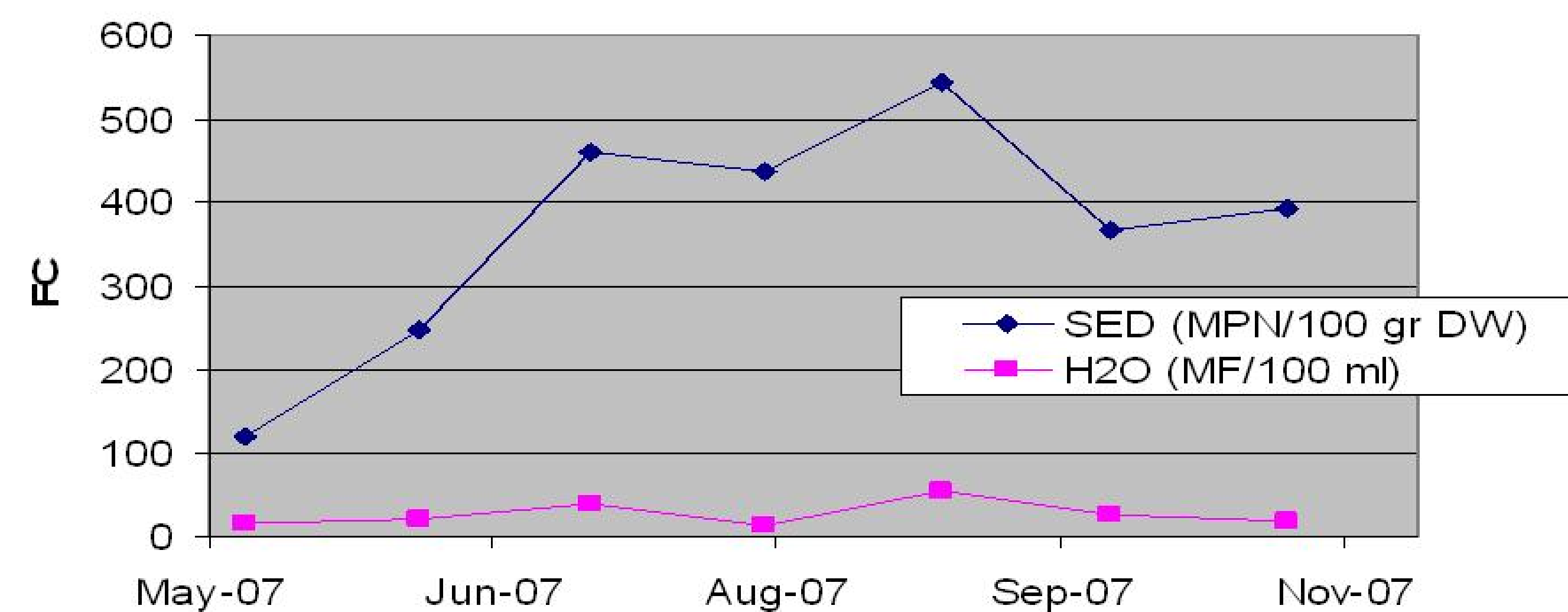
- FC counts at the marine snow-sediment interface increased from May (119 MPN/100gr DW) to September (544 MPN/100gr DW).
- FC counts decreased from September to November (393 MPN/100gr DW), but not back to May lows.
- Differences in monthly mean FC counts were not statistically significant likely because of small sample size, and considerable spatial and temporal variability.
- The slow return to low winter counts suggests a more indirect relationship between summer conditions and bacteria growth than expected, perhaps driven by marine snow deposition patterns or some other ecological processes that extend later into the calendar year.



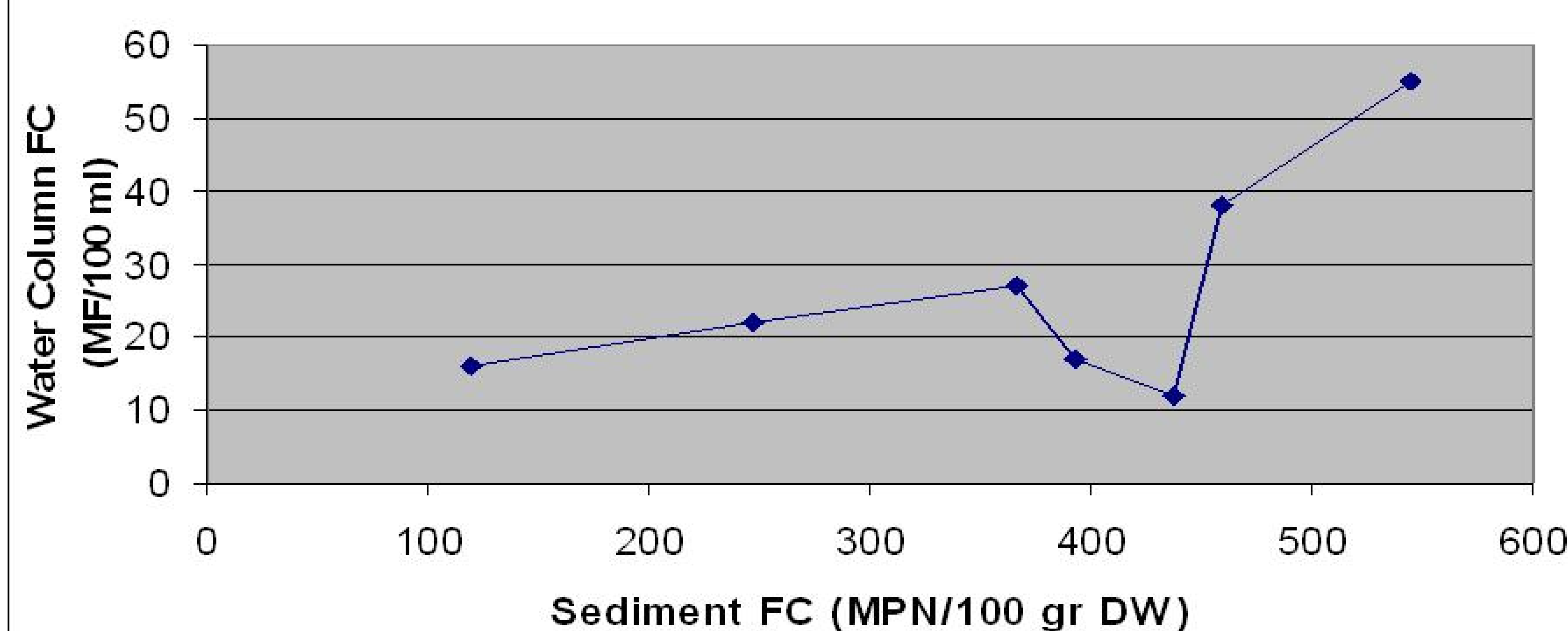
Oakland Bay Shellfish Protection District



DOH 614: monthly mean FC in sediment and water column



DOH 614: relationship between FC in sediment and water column



Methods—Wind

- DOH collected 65 water column FC samples at DOH 614 between May 2002 and June 2006.
- The samples were re-analyzed for co-variation with wind speed and wind direction.
- Collection day mean daily wind speed and direction data came from the Shelton airport weather station.

Results

- An ANOVA was significant ($P = 0.035$).
- Wind speed was a significant covariate ($P = 0.036$), but did not explain a significant portion of the variation in FC counts ($R^2 = 0.084$).
- Using mean wind speed over a four hour period just prior to sampling, R^2 increased to 0.32.
- Wind direction was not a significant covariate ($P = 0.083$), but the power of analysis to detect differences was not great (power = 0.56).

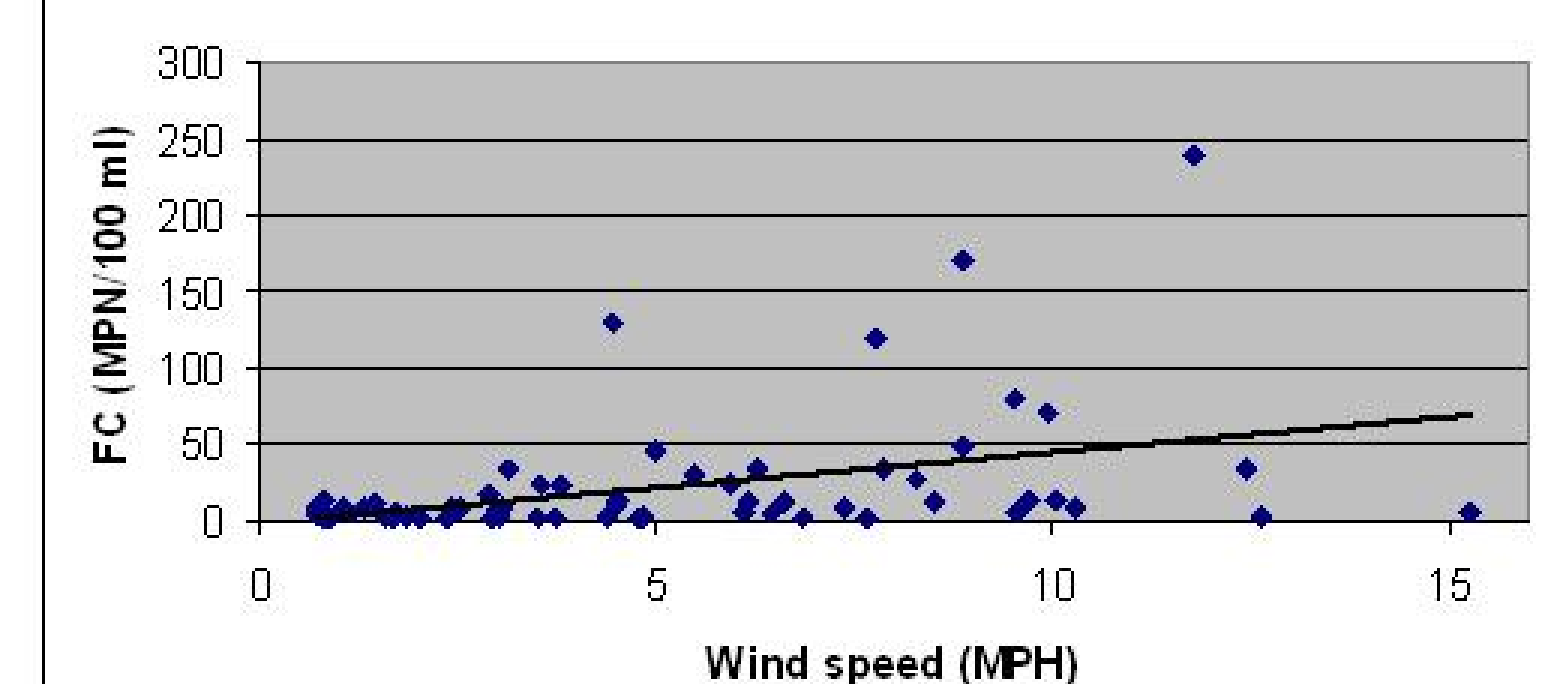
Conclusions

- Differences in FC count by wind quadrant were not significant likely because most strong winds came from the SW and limited the sample size for other quadrants.
- Wind speed likely increased tidal action and the resulting scouring velocity to re-suspend sediment and bacteria into the water column.

FC by Wind Speed & Direction

Wind Speed	Wind Quadrant	
	MPN/100 ml	
< 5 MPH	20 (11 samples)	7 (22 samples)
≥ 5 MPH	72 (27 samples)	14 (5 samples)

DOH 614: relationship between wind speed and FC in water column



Discussion

- The SW-NE geographic alignment of Oakland Bay provides a 5 mile long fetch to accentuate wind and wave action at DOH 614.
- This geographic orientation did not produce extremely high summer FC counts in 2002, 2003, 2004 or 2007.
- Some larger climatic influence evident in 2005 and 2006 may be a factor adding variability to inter-annual FC counts at DOH 614.
- Lower FC counts in 2007 might have been partially influenced by repair of a failing septic system on the south shore across Deer Creek.
- The analysis suggests that the conceptual model of FC growth on the sediment surface and re-suspension under windy conditions requires further investigation.